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RESEARCH ARTICLE

First record of the Asian mud-dauber wasp *Sceliphron curvatum* (Hymenoptera, Sphecidae) in Cyprus, including an identification key and notes on its possible impacts

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Abstract

Sphecidae *sensu lato* currently includes more than 10,000 species of which 34 belong to the genus *Sceliphron* Klug, 1801. In Europe and the Mediterranean Basin, three out of eight species of *Sceliphron* are alien to the region, including the Asian *S. curvatum* (Smith, 1870) and *S. deforme* (Smith, 1856) as well as the Nearctic *S. caementarium* (Drury, 1773). Up-to-date, only three species of *Sceliphron* have been reported for Cyprus, *S. destillatorium*, *S. madraspatanum tubifex* and *S. spirifex*, being native to the island. In this publication, *S. curvatum* is reported for the first time as a new alien mud-dauber to the island. Specimens were first observed in 2020 at Xyliatos (Nicosia) and reared from nests collected in 2023 upon annual surveys. In addition, nests of both *S. curvatum* and *S. spirifex* co-existing at the site were opened providing preliminary data on spider prey. A literature investigation compared with the national list of spiders in Cyprus provides an insight into potential spider prey while a dichotomous identification key, including alien *S. caementarium* and *S. deforme* yet to be reported from the island, is provided. The number of *Sceliphron* species known from Cyprus is raised to four. More research is

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PENSOFT

necessary to elucidate the biotic interactions of *Sceliphron* in Cyprus, the invasiveness and the further spread of *S. curvatum* on the island.

Keywords
alien species, biotic interactions, identification key, new record, spiders, *Sceliphron curvatum*.

Introduction

The subgroup Spheciformes (Sphecidae *sensu lato*) is currently represented by 10,152 species (Pulawski 2020). Amongst them, the wasp genus *Sceliphron* Klug, 1801 is rather small and includes only a total of 34 extant species, distributed across temperate and tropical regions worldwide (Bohart and Menke 1976; Pulawski 2020). In Europe and the Mediterranean Basin, eight species have been recorded out of which three are reported as alien. These alien species are *S. curvatum* (Smith, 1870) and *S. deforme* (Smith, 1856) native to South and East Asia as well as the Nearctic *S. caementarium* (Drury, 1773) (Ćetković et al. 2004; Schmid-Egger 2005; Ćetković et al. 2011). Although *S. caementarium* and *S. curvatum* are widely distributed in the region (Bogusch et al. 2005; Schmid-Egger 2005; Wišniowski et al. 2013; Gulmez and Can 2015; Demetriou et al. 2022; Ertürk and Taş 2022; Ceccolini 2023), *S. deforme* is known to inhabit Greece, Montenegro and Russia within its introduced range in Europe (Ćetković et al. 2011; Prisniy 2021).

The island of Cyprus is situated in the heart of the Eastern Mediterranean Sea and with an area of 9251 km^2 it is the 3rd largest island in the Mediterranean Basin, a global biodiversity hotspot (Myers et al. 2000). Recent studies on wild bees have shown an endemism rate of 5.7%, with 21 out of a total of 369 species being endemic to the island (Varnava et al. 2020), while looking into relatively understudied parasitic hymenopteran taxa such Braconidae and Chalcidoidea, these percentages are 0.9% (1/113) and 2.4% (3/124), respectively (Noyes 2019; Beyarslan 2022). Regarding Sphecidae *sensu lato*, a total of 137 species have been recorded from the island with 12 species and subspecies being endemic (endemism rate = 8.8%) (Guiglia 1944; de Beaumont 1947; Pittioni 1950; de Andrade 1953; Balthasar 1954; Georghiou 1977; Leclercq 1993; Pulawski 2020).

Up-to-date, only three native species of *Sceliphron* have been reported for Cyprus. In particular, *S. destillatorium* (Illiger, 1807), *S. madraspatarum tubifex* (Latreille, 1809) and *S. spirifex* (Linnaeus, 1758) (de Beaumont 1947; Pittioni 1950; van der Vecht and van Breugel 1968; Georghiou 1977; Dollfuss 2016; Edwards et al. 2016; Fauna Europaea 2023). Despite the mention of Cyprus within the distributional range of *S. caementarium* in Wikipedia (https://en.wikipedia.org/wiki/Sceliphron_caementarium - in turn citing Fauna Europaea), to the best of our knowledge, no records of the species have been traced in published literature, social media or during authors' material surveys (Demetriou et al. 2022; Ceccolini 2023). Although it is common knowledge that several mistakes occur within the Fauna Europaea database, Cyprus

is not mentioned within the distributional range of *S. caementarium,* while records of *S. destillatorium* and *S. spirifex* on the site are backed up by specimens deposited in the last author's collection as well as scientific literature in the case of *S. spirifex* (de Beaumont 1947; Pittioni 1950; Georghiou 1977; Dollfuss 2016).

In this publication, recurring annual material surveys in Xyliatos (Nicosia province) from 2020 to 2023 provide evidence of the presence of *S. curvatum*, which is reported for the first time as a new alien species to the island of Cyprus. A dichotomous identification key to the *Sceliphron* of Cyprus is provided to assist rapid detection and future spread of alien species, including alien *S. caementarium* and *S. deforme* which have not been yet detected on the island. Finally, spider prey of *Sceliphron* spp. found in Cyprus is assessed based on literature and specimens identified from nests of *S. curvatum* and *S. spirifex* in Cyprus, to evaluate the possible adverse impacts of further spread of *S. curvatum* as well as its trophic niche overlap with other native *Sceliphron* of Cyprus.

Materials and methods

Study area and material surveys

The study area was mainly the Xyliatos Dam Picnic Site (Nicosia/Lefkosia). This site is in a river bed under the wall of Xyliatos Dam, with riparian vegetation inside a pine forest. The riparian vegetation consists mainly of Oriental alder (*Alnus orientalis*) and Oriental plane (*Platanus orientalis*). The pine forest is a homogeneous East Mediterranean pine (*Pinus brutia*) forest. We examined structures that *Sceliphron* species may build their nests on/in i.e. bridges, benches, drainage pipes and other suitable structures (Figs. 1B–E). *Sceliphron curvatum* was first observed by the first author on the 11th of July 2020, building a nest on a bench in the surroundings of Xyliatos Dam. He took some photos and video (Fig. 1A, Youtube) but didn't collect the specimen. Upon communication between the authors the specimen was preliminary identified as either *S. curvatum* or *S. deforme*, deeming the collection and identification of specimens necessary to avoid potential misidentification. Thus, the observation site was visited some days later but the nest was broken and we failed to find another specimen or nest.

Since the first observation, we performed repeated annual visits to the area during the late spring and summer months to locate specimens and nests. At the same time, we collected nests of co-existing *S. spirifex* to examine the spider species it preyed upon. During our visits, we located many old *S. curvatum* nests mainly in drainage pipes. Three years after repeated attempts, on the 14th of July 2023 we located a specimen of *S. curvatum* building nest cells in a crack on an underground bridge (Figs. 1C, 1E). The nest was at its final stage of construction and the parental specimen was covering the crack with mud to hide the cells. Capturing the parental specimen was unsuccessful so we collected all possible active cells but because of

Figure 1. A The first observation of *Sceliphron curvatum*; **B**, **C** Nest cells of *S. curvatum*; **D**, **E** Structures that were found in nest cells of *S. curvatum* were found.

the difficulty of accessing them, some of them broke and part of their content was lost. A total of seven *S. curvatum* specimens emerged from the collected nest cells.

Identification of material

Specimens of *Sceliphron* spp. were mounted and identified through a stereoscope based on the identification keys of Hensen (1987), Bitsch et al. (1997) and Schmid-Egger (2005). The following collections were examined for material:

GKPC: George Konstantinou Personal Collection, Nicosia, Cyprus.
JDPC: Jakovos Demetriou Personal Collection, Paphos, Cyprus.
MHPC: Michael Hadjiconstantis Personal Collection, Nicosia, Cyprus.
ZMUA: Museum of Zoology of the University of Athens, Athens, Greece.

In addition, spiders in nest cells of *S. curvatum* and *S. spirifex* collected by the second author were identified through a stereoscope based on the identification keys provided in https://araneae.nmbe.ch information from Bosmans et. al. (2019) and by comparing specimens in MHPC and GKPC, to acquire preliminary data on ecological interactions with other species.

Identification key

A dichotomous identification key for the *Sceliphron* of Cyprus was created based on examined material and scientific literature (Hensen 1987; Schmid-Egger 2005; Bitsch 2010; Díaz-Calafat 2020). Morphological terminology follows Bohart and Menke (1976). As the identification of species within the genus *Sceliphron* in Europe has been already well-presented by Hensen (1987) and Schmid-Egger (2005) we did not examine an abundance of material from each species. Nevertheless, given the necessity for early warning and rapid response systems on reporting on the introduction and further spread of alien species (Reaser et al. 2020), we included *S. caementarium* and *S. deforme* in the identification key to assist identification efforts during possible interceptions or collection.

Trophic interactions – Spider prey

A thorough literature review was carried out by the third author. Spider prey data for *S. curvatum*, *S. destillatorium*, *S. madraspatanum* and *S. spirifex* were accumulated and the resulting species list was correlated against the checklist of Cypriot spiders by Bosmans et al. (2019), to evaluate the possible adverse impact of further spread of *S. curvatum* as well as its trophic niche overlap with other native *Sceliphron* of Cyprus. Where spider specimens were identified to genus level, if this genus was found in Cyprus it was added to the checklist. Additionally, data from nests of *S. spirifex* and *S. curvatum* collected from the Xyliatos area were added to the checklist (Table 1).

Table 1. Possible and identified spider prey of alien *S. curvatum* (*S.c.*) and native *S. destillatorium* (*S.d.*), *S. madraspatanum* (*S.m.*) and *S. spirifex* (*S.s.*) in Cyprus based on scientific literature, Bosmans et al. (2019) and examined spider material from nests of *S. curvatum* and *S. spirifex* in Cyprus.

Species	*S. c.*	*S. d.*	*S. m.*	*S. s.*	References
Araneidae					
Aculepeira armida (Savigny et Audouin, 1826)		X			Fateryga and Kovblyuk (2014)
Agalenatea redii (Scopoli, 1763)		X		X	Lucas (1869); Sychevskaya (1973)
Anyphaena sabina Sundevall, 1833	X				Gulmez and Can (2015)
Araneus diadematus Clerck, 1758	X	X		X	Polidori et al. (2005); Fateryga and Kovblyuk (2013); Gulmez and Can (2015)
Araneus sp.	X		X		Polidori et al. (2005); Hellrigl (2006); Gulmez and Can (2015)
Araniella alpica (L. Koch, 1869)	X				Hellrigl (2006)
Araniella sp.	X	X			Gepp and Bregant (1986); Kovalchuk and Rutkowski (2015); Szinetár and Fazekas (2015)
Argiope lobata (Pallas, 1772)		X			Fateryga and Kovblyuk (2014)
Cyclosa sierrae Simon, 1870		X			Fateryga and Kovblyuk (2014)
Gibbaranea sp.	X				Hellrigl (2006)
Gibbaranea bituberculata (Walckenaer, 1802)				X	Polidori et al. (2005)
Larinioides sp.	X			X	Polidori et al. (2005); Fateryga and Kovblyuk (2013)
Mangora acalypha (Walckenaer, 1802)		X			Sychevskaya (1973); Fateryga and Kovblyuk (2014)
Neoscona adianta (Walckenaer, 1802)		X			Sychevskaya (1973); Fateryga and Kovblyuk (2014)
Neoscona subfusca (C.L. Koch, 1837)	X			X	Fateryga and Kovblyuk (2013); present study
Zilla diodia (Walckenaer, 1802)	X				Fateryga and Kovblyuk (2013)
Zygiella sp.	X				Fateryga and Kovblyuk (2013)
Cheiracanthidae					
Cheiracanthium erraticum (Walckenaer, 1802)		X			Sychevskaya (1973)
Clubiona					
Clubiona sp.	X				Fateryga and Kovblyuk (2013)
Gnaphosidae					
Drassodes lapidosus (Walckenaer, 1802)		X			Sychevskaya (1973)
Scotophaeus sp.	X				Fateryga and Kovblyuk (2013)
Lycosidae					
Lycosa sp.		X	X		Sychevskaya (1973); Halder et al. (2012)
Oxyopidae					
Oxyopes heterophthalmus (Latreille, 1804)	X	X			Fateryga and Kovblyuk (2014); present study
Oxyopes lineatus Latreille, 1806	X	X			Sychevskaya (1973); Fateryga and Kovblyuk (2013, 2014)

Table 1. (continued)

Species	*S. c.*	*S. d.*	*S. m.*	*S. s.*	References
Philodromidae					
Philodromus aureoles (Clerck, 1757)	X	X			Sychevskaya (1973); Hellrigl (2006)
Philodromus cespitum (Walckenaer, 1802)	X			X	Polidori et al. (2005); Gulmez and Can (2015)
Philodromus longipalpis Simon, 1870	X				Szinetár and Fazekas (2015)
Philodromus margaritatus (Clerck, 1757)	X				Hellrigl (2006)
Philodromus sp.	X				Gepp and Bregant (1986); Szinetár and Fazekas (2015); present study
Thanatus sp.	X				Fateryga and Kovblyuk (2013)
Pisauridae					
Pisaura mirabilis (Clerck, 1757)		X			Sychevskaya (1973)
Pholcidae					
Holocnemus pluchei (Scopoli, 1763)				X	present study
Salticidae					
Evarcha falcata (Clerck, 1757)		X			Kovalchuk and Rutkowski (2015)
Heliophanus sp.	X				Fateryga and Kovblyuk (2013)
Macaroeris nidicolens (Walckenaer, 1802)	X				Fateryga and Kovblyuk (2013); Gulmez and Can (2015); Szinetár and Fazekas (2015); present study
Marpissa sp.			X		Halder et al. (2012)
Pellenes sp.	X				Fateryga and Kovblyuk (2013)
Philaeus chrysops (Poda, 1761)	X				Fateryga and Kovblyuk (2013); Gulmez and Can (2015)
Pseudicius picaceus (Simon, 1868)	X				Gulmez and Can (2015); present study
Salticus sp.	X				Fateryga and Kovblyuk (2013)
Tetragnathidae					
Tetragnatha sp.			X		Begum et al. (1989)
Theridiidae					
Enoplognatha sp.		X			Sychevskaya (1973)
Neospintharus syriacus (O. Pickard-Cambridge, 1872)				X	present study
Thomisidae					
Misumena vatia (Clerck, 1757)	X	X			Eversmann (1848); Sychevskaya (1973); Fateryga and Kovblyuk (2014); Szinetár and Fazekas (2015)
Runcinia grammica (Koch, 1837)		X			Fateryga and Kovblyuk (2014)
Steatoda albomaculata (De Geer, 1778)		X			Sychevskaya (1973)
Thomisus onustus Walckenaer, 1805	X	X		X	Mazek-Fialla (1936); Sychevskaya (1973); Fateryga and Kovblyuk (2014); present study
Tmarus piochardi (Simon, 1866)	X			X	present study
Tmarus sp.	X				Fateryga and Kovblyuk (2013)
Xysticus sp.	X				Fateryga and Kovblyuk (2013)
Uloboridae					
Uloborus walckenaerius Latreille, 1806				X	present study
SUM species	17	18	0	10	excluding identifications to genus level

Results

Sceliphron spp. – material examined

Sceliphron curvatum (Smith, 1870) – first record

GREECE: 2 ex., Attica [Attiki], Zografou, Panepistimioupolis [37.9719° N, 23.7984° E], 7.vi.2019 + 18.ix.2019, leg and det. J. Demetriou, deposited in JDPC.; 2 ex., Attica, Zografou, Panepistimioupolis [37.966° N, 23.778° E], 9.vii.2019 – 15.vii.2021, leg. E. Koutsoukos (KCV), det. J. Demetriou, deposited in JDPC.

CYPRUS: 1 ex., Nicosia, Xyliatos, dam area [35.0102° N, 33.0375° E], 11.VII.2020, obs. G. Konstantinou, photographed (Fig. 1A) and filmed (https://www.youtube.com/watch?v=XX7C7foHCoo); 7 ex., Nicosia, Xyliatos, dam area [35.0102° N, 33.0375° E], 19.VII.2023 – 27.VII.2023, leg. M. Hadjiconstantis, det. J. Demetriou, 4 deposited in JDPC and 3 in MHPC (Figs. 2A–B).

Sceliphron caementarium (Drury, 1773)

GREECE: 1 ex. Attica [Attiki], Athens [Athina], Kryoneri [38.1450°N, 023.8340°E], 3.VIII.2016, leg. Dr. Christos Georgiadis, det. J. Demetriou, deposited in the ZMUA (voucher code: ZMUA HYM 00000011).; 1 ex., Attica [Attiki], Athens [Athina], Nea Peramos, [38.0012°N, 023.4198°E], 8.VIII.2021, leg. E. Koutsoukos, det. J. Demetriou, deposited in the ZMUA (voucher code: ZMUA HYM 00000241) [as in Demetriou et al. (2022)].

Sceliphron destillatorium (Illiger, 1807)

CYPRUS: 2 ex., Paphos, Akamas Peninsula, Lara – Toxeftra beach [34.9179° N, 32.3283° E], alt. 16 m, 14–15 + 20.vi.2020, leg. and det. J. Demetriou, deposited in JDPC.

Sceliphron madraspatarum tubifex (Latreille, 1809)

CYPRUS: 1 ex., Paphos, Akamas Peninsula, Lara – Toxeftra beach [34.9179° N, 32.3283° E], alt. 16 m, 14–15 + 20.vi.2020, leg. and det. J. Demetriou, deposited in JDPC.; 2 ex., Paphos, Akamas Peninsula, Avakas Gorge, [34.9204° N, 32.3381° E], alt. 36 m, 9.viii.2020, leg. and det. J. Demetriou, deposited in JDPC.; 1 ex., Paphos, Chloraka, Melanos, [34.79° N, 32.41° E], alt. 90 m, 1.vii – 31.viii.2020, leg. and det. J. Demetriou, deposited in JDPC.; 2 ex., Akrotiri UK SBA, Akrotiri marsh [34.6317° N, 32.933 ° E], alt. 0 m, leg. and det. J. Demetriou, deposited in JDPC.

Sceliphron spirifex (Linnaeus, 1758)

GREECE: Attica, Salamina, Nafstathmos [37.9798° N, 23.5321° E], alt. 15 m, 1–31.x.2017, leg. E. Koutsoukos, det. J. Demetriou, deposited in JDPC.

CYPRUS: 1 ex., Paphos, Chloraka, Melanos, [34.79° N, 32.41° E], alt. 90 m, 1–30. vi.2020, leg. and det. J. Demetriou, deposited in JDPC.; 1 ex., Paphos, Chloraka, Melanos, [34.79° N, 32.41° E], alt. 90 m, 1.vii – 31.viii.2020, leg. and det. J. Demetriou, deposited in JDPC.; 2 ex., Paphos, Akamas Peninsula, Avakas Gorge, [34.9204° N, 32.3381° E], alt. 36 m, 9.viii.2020, leg. and det. J. Demetriou, deposited in JDPC.; 1 ex., Nicosia, Agios Sozomenos – Potamia [35.04° N, 33.44° E], alt. 190 m, 25.vii.2020, leg. C. Makris and J. Demetriou, det. J. Demetriou, deposited in JDPC.; 1 ex., Limassol, Molos [34.6753° N, 33.0479° E], alt. 0 m, 7.x.2021, leg. and det. J. Demetriou, deposited in JDPC.

Spider prey material examined

Sceliphron curvatum nest cells (Fig. 2D)

Araneae: *Neoscona subfusca* (C.L. Koch, 1837), 1♀; Philodromidae: *Philodromus* sp. 6♀; Salticidae: *Macaroeris nidicolens* (Walckenaer, 1802), 4♀ 3♂; *Pseudicius picaceus* (Simon, 1868), 43♀ 11♂; Oxyopidae: *Oxyopes heterophthalmus* (Latreille, 1804), 1♀; Thomisidae: *Thomisus onustus* Walckenaer, 1805, 1♀; *Tmarus piochardi* (Simon, 1866), 4♀. det. M. Hadjiconstantis, deposited in MHPC.

Sceliphron spirifex nest cells

Araneae: *N. subfusca,* 27♀ 4♂; Pholcidae: *Holocnemus pluchei* (Scopoli, 1763), 26♀ 18♂; Theridiidae: *Neospintharus syriacus* (O. Pickard-Cambridge, 1872) 1♂; Thomisidae: *T. onustus,*1♀ *T. piochardi* 3♀; Uloboridae: *Uloborus walckenaerius* Latreille, 1806, 1♀. det. M. Hadjiconstantis, deposited in MHPC.

Nest parasites of Sceliphorn cells

Forty percent of the collected nest cells *of S. curvatum* were hosted by the cuckoo wasp species *Chrysis taczanovskii* Radoszkowski, 1876 (Fig. 2C, 3C–D), while 20% of the collected nest cells of *S. spirifex* were hosted by the Bombyliid fly *Anthrax sticticus* Klug, 1832 (Fig. 3A–B) and 10% by the cuckoo wasp *C. taczanovskii*.

The identification of the cuckoo wasp *C. taczanovskii* was performed by Mr Christodoulos Makris and for the Bombyliid fly *A. sticticus* by M. Hadjiconstantis based on the key provided in El-Hawagry (2021).

Key to species of the genus *Sceliphron* (Klug, 1801) present in Cyprus, including alien species with the potential to arrive and establish on the island

1 – Colouration of body black, yellow and reddish brown. Legs with reddish tarsi or extensively red. Abdomen black with reddish and yellow markings 2*
– Colouration of whole body and legs black and yellow 3

2 – Yellow markings restricted to the centre of clypeus. Scutum matt/dull. Abdominal tergite 1 flat in lateral view, same size and height as 2nd tergite ..... *S. curvatum* (alien species)
– Yellow markings extended from the centre towards the outer edges of clypeus. Scutum shiny. Abdominal tergite 1 shown as swollen in lateral view, with clear depression between the 1st and 2nd tergite. Petiole more curved than in *S. curvatum* ..... *S. deforme* (alien species not present in Cyprus)

3 – Hind femora completely black. [Scapes yellow, mesosoma black with yellow pronotum (collar), tegula, scutellum, and metanotum, and two yellow spots on the mesopleuron. Propodeum yellow and 1st abdominal tergite usually with yellow spot. Petiole usually black, less frequently yellow or bicoloured. Note that yellow markings can be more-or-less obvious as melanistic individuals have been also noted] ... *S. caementarium* (alien species not present in Cyprus)
– Hind femora bicoloured black and yellow. Combinations not as above 4

4 – Pronotum (collar) yellow. Hind coxa, as seen dorsally, rounded. Propodeum with two vertical yellow stripes or spots resembling ill-defined stripes ..... *S. mandraspatarum tubifex*
– Pronotum (collar) black. Hind coxa, as seen dorsally, with right-angled corners. Propodeum without yellow markings 5

5 – Thorax completely black (including tegula) ..... *S. spirifex*
– Thorax mostly black. Both sexes with yellow tegula; in females postscutellum also yellow ..... *S. destillatorium*

* For diagrammatic depicture of characters separating *S. curvatum* and *S. deforme* see also Schmidt-Egger (2005) Abbs. 1 + 2, p. 9.

Discussion

This study presents the first evidence regarding the detection and establishment of *S. curvatum* in Cyprus. We believe the species might be restricted to the area of Xyliatos. This hypothesis is supported by: (1) the authors being active in the field in areas of Paphos, Limassol and Nicosia districts, (2) surrounding areas of similar

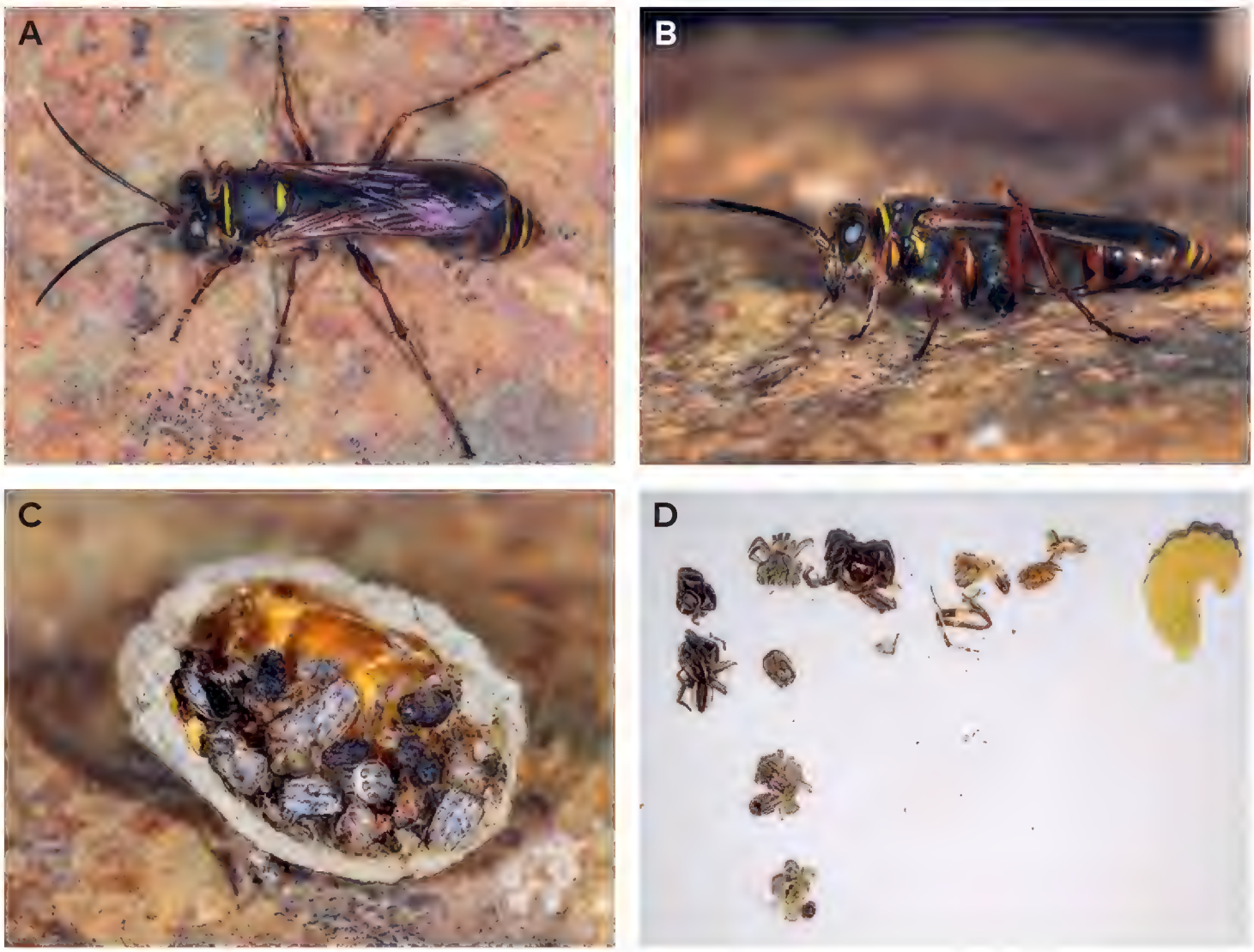

Figure 2. A, **B** *Sceliphron curvatum* specimen that emerged from collected nest cells; **C** opened *S. curvatum* nest cell parasitised by *Chrysis taczanovskii*; **D** Spider pray specimens and larva of *S. curvatum* (right) from one nest cell.

habitat such as the Vyzakia reservoir yielding no specimens upon inspection and (3) the absence of records in citizen science platforms such as iNaturalist and the "Biodiversity of Cyprus" Facebook group. Nevertheless, more research is necessary to assess the distribution of the species as well as its further spread on the island. Similar habitats i.e. dams and irrigation tunnels as well as urban habitats could be further surveyed since *S. curvatum* is known to be highly synanthropic (Bilański et al. 2014; Polidori et al. 2020; Bogusch 2022). Schmidt-Egger (2005), hypothesised that the species may have expanded its distribution in Europe following valleys of great European rivers. As such, the species could potentially also spread in Cyprus following the nearby Lagoudera stream and Elias River. Our record of *S. curvatum* in Cyprus represent a rare case of the species nesting outside urban areas, in a natural habitat nevertheless under anthropogenic influence, in contrast to its commonly indoors nesting habits observed in central European countries (Bogusch 2022). The observed establishment of this alien species in a natural habitat adds more data into previous statements of alien taxa being more easily integrated in natural areas in the Mediterranean (Yus-Ramos et al. 2014).

The introduction pathway of *S. curvatum* to Cyprus is currently unknown. According to EASIN (2023), this is also the case for all alien *Sceliphron* spp. in Europe. Bogusch et al. (2005) assumed that *S. curvatum* was introduced to Europe via human agency but later on spread throughout the continent unaided. Nevertheless, in the case of Cyprus nests of *S. curvatum* could also be potentially introduced as stowaways in containers, machinery/equipment, people and their luggage/equipment, and vehicles or as hitchhikers on aeroplanes, ships or boats. As the site of the first record in Cyprus lies far from possible points of entry such as airports or ports we hypothesize that it could have reached the area in some container or equipment used for the construction of the surrounding camping site, upgraded under the Rural Development Programme 2014–2020. Alternatively, the species may have reached the island flying from Turkey. Although the minimum distance between Cyprus and Turkey is approximately 70 km, this hypothesis is weakened by the known distribution of *S. curvatum* in Turkey limited to its northern part bordered by the Black Sea (Gulmez and Can 2015; Ertürk and Taş 2022). Our records of *S. curvatum* elevate the known species of the genus *Sceliphron* inhabiting Cyprus to four. However, as two more alien species have been reported from Europe the provided identification key aims to facilitate the identification of collected and observed individuals, assist

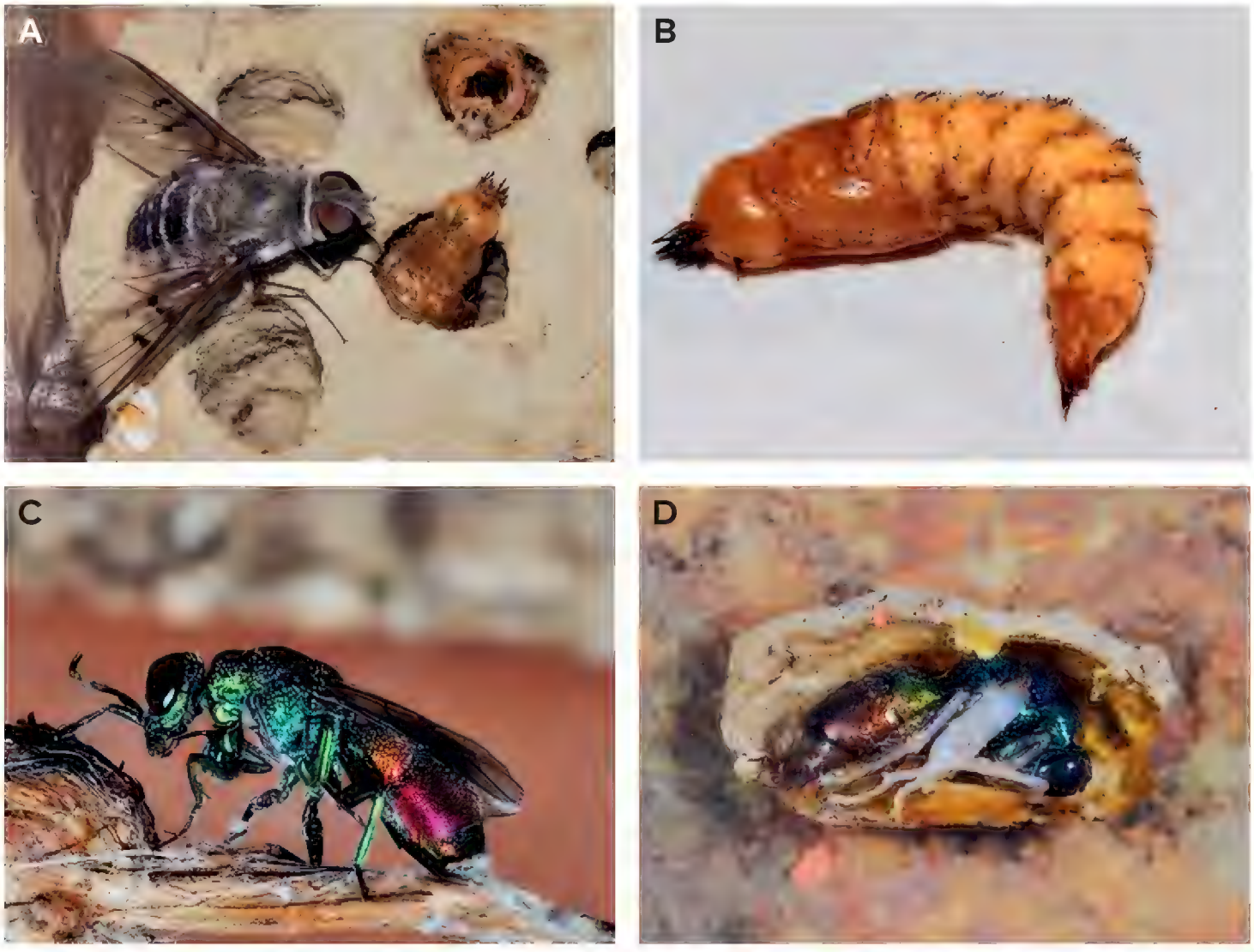

Figure 3. **A** *Anthrax sticticus* freshly emerged from *S. spirifex* nest cell; **B** Pupa of *Anthrax sticticus*; **C** *Chrysis taczanovskii*; **D** Pupa of *Chrysis taczanovskii*.

mapping efforts for *S. curvatum* on the island as well as provide an early detection in the case of possible introductions of *S. caementarium* and *S. deforme*.

Regarding biotic interactions, *C. taczanovskii* (Chrysididae) was recorded as a parasite in nests of the alien *S. curvatum* and native *S. spirifex*. Although *C. taczanovskii* has been reported to parasitize *S. destillatorium* (Crimea) (Fateryga and Kovblyuk 2014), this host-parasite relationship was questioned by Rosa et al. (2019) as *C. taczanovskii* was also reared from nests of *Euodyenrus disconotatus* (Lichtenstein, 1884) by Martynova and Fateryga (2015). In *Sceliphron* nests collected on Cyprus, *C. tacznovskii* emerged from clay nests where after its exit only fragments of legs and dorsal parts of the cephalothorax of spiders was uncovered (Fig. 2C). Three larvae of *C. tacznovskii* were also observed to actively feed on spider abdomens and the ventral part of their cephalothorax leaving behind the aforementioned fragments. No caterpillars or immature stages of Eumeninae or *Sceliphron* where found and no adult imagos of Eumeninae were reared. Based on the available literature, we hypothesize that *C. taczanovkii* could be a parasitoid of both Eumenine and *Sceliphron* spp., supporting findings of Fateryga and Kovblyuk (2014) and Martynova and Fateryga (2015). The cuckoo wasp larvae probably lay their eggs in active nests of *Sceliphron* spp. and abandoned nests with Eumeninae inquilines, first feeding on the wasp larvae or egg and continuing with the consumption of nest provision until their full development and emergence. Therefore, *C. taczanovkii* is probably a generalist parasite of both Sceliphron and Eumeninae as observed in species such as *Chrysis angolensis* Radoszkowski, 1881, *Stilbum calens* (Fabricius, 1781) and *Stilbum cyanurum cyanurum* (Förster, 1771) (Rosa et al. 2019). Furthermore, it is worth mentioning that no spider remains were found in nests from which *S. curvatum* or *A. sticticus* emerged.

To the best of our knowledge, no data on the parasitism of *Sceliphron* spp. were uncovered for *A. sticticus* (Bombyliidae). Its association with *S. spirifex* is presented as a new host record. Based on our preliminary data from spiders identified in nests of *S. curvatum* and *S. spirifex* in the Xyliatos area, *S. curvatum* preyed on *N. subfusca* (Araneidae), *O. heterophthalmus* (Oxyopidae), *M. nidicolens* and *P. picaceus* (Salticidae), unidentified species of the genus *Philodromus* (Philodromidae), *T. piochardi* and *T. onustus* (Thomisidae). Respectively, *S. spirifex* preyed on *N. subfusca* (Araneidae), *N. syriacus* (Theriidae), *U. walckenaerius* (Uloboridae), *H. pluchei* as well as *T. piochardi* and *T. onustus* (Thomisidae). Although it may seem that a niche partitioning between the two species exists, more research is necessary to assess the impacts of *S. curvatum* on native *Sceliphron* spp. According to our literature investigation, *S. curvatum* could potentially prey upon a vast range of spiders native to Cyprus (Table 1). Particularly, 17 native species as well as potentially other species within the genera *Araneus*, *Araniella*, *Gibbaranea*, *Larinioides*, *Zygiella* (Araneidae), *Clubiona* (Clubiona), *Scotophaeus* (Gnaphosidae), *Thanatus* (Philodromidae), *Heliophanus*, *Pellenes*, *Salticus* (Salticidae), *Tmarus* and *Xysticus* (Thomisidae). Our lack of spider material in nests of *S. destillatorium* and *S. madraspatanum tubifex* from Cyprus in addition to the absence of data for spiders potentially preyed upon

by *S. madraspatanum* indicates the necessity for more research on the topic. This is particularly important considering the adverse impacts of biological invasions on island species and their evolutionary histories (Mooney and Cleland 2001; Reaser et al. 2007; Russell et al. 2017).

Taking into consideration the ever-increasing numbers of alien species worldwide (Seebens et al. 2017) due to globalization and international trade (Hulme 2009; Seebens 2019), future studies could also incorporate data on parasitoids and inquilines of *Sceliphron* spp. nests potentially uncovering records of new alien species such as *Chalybion bengalense* (Dahlbom, 1845) (Mei 2012) or *Melittobia australica* Girault, 1912 (Cusumano et al. 2012) translocated with nests of native or alien *Sceliphron* spp.

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